

Mineral Investigations Along the Pipeline Corridor, 1979

A Preliminary Report

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## I-INTRODUCTION

This report will serve as a status report for work completed on mineral investigations of the pipeline corridor in the 1979 field season. This study was undertaken as part of a continuing program contracted under the Memorandum of Understanding (MOU) between the Bureau of Mines (BM) and the Bureau of Land Management (BLM), AK-950-MU8-13, 1977.

The statement of work for the 1979 field season is detailed in Addendum Number 1 to the MOU. This work statement was later modified in a letter to Stan Shephard, BLM, Anchorage, from James Barker, Alaska Field Operations Center, Fairbanks, dated May 11, 1979. Site-specific investigations along the pipeline corridor between Fairbanks and the Brooks Range were undertaken in areas that current data indicated would have the highest probability for deposits of economically important minerals.

Field work was completed in all designated areas, with the exception of the studies of copper and zinc as shale-hosted deposits possibly occurring west of Dietrich Camp. Requests made to the Park Service for permission to enter Gates of the Arctic National Monument were denied, necessitating a mid-season change in the work plan. Because of the cost, in both funds and field time, of moving camp up to the Brooks Range, it was decided that unless the entire geologic trend was open to investigation, it would not be wise to attempt a study of the area. Furthermore, interesting discoveries of chromite deposits in the Kanuti River area warranted more time spent detailing the occurrence of these deposits.

Field work is now completed on the 1979 pipeline project. The remainder of 1979 will be devoted to analysing the more than 200 thin sections collected this summer and drafting up maps to be used in interpretation of geochemical data, currently being analysed. By 1980 all sample results should be in hand, and writing of the final report will commence.

## II-INVESTIGATION OF LODE AND PLACER GOLD, LIVENGOD DISTRICT

### A-Introduction

Placer gold has been mined intermittently in the Livengood district since its discovery on Livengood Creek in 1914. Small bedrock occurrences of epithermal affinity have also been described (Foster, 1967 and 1968). It is unclear whether the latter are the source of the placer gold or, whether similar occurrences might prove to be viable targets for future exploration. Foster (1968) has suggested that the small bedrock deposits or related ones at depth are indeed the source and the testing of his model would ultimately require an extensive drilling program.

It is the purpose of this study to investigate the surface expression of any epithermal activity by using geological and geochemical methods. This is done with the intent of relating the placer deposits to bedrock occurrences on the basis of surficial data.

Approximately 16 man days were spent in the area with one day of helicopter support.

### B-Geochemistry

Samples collected during this study include 68 rock samples, 33 panned concentrates from stream sediments, two concentrates from sluiced gravels and one sample of dirt from a pay streak. Rock samples are to be examined petrographically as well as analysed for elemental content. The dirt sample, panned and sluiced concentrates are to be examined petrographically and splits will be processed to quantitatively determine gold and heavy mineral content. Trace element analyses of pyrite, arsenopyrite and gold particulates will be carried out using electron microprobe techniques. These procedures will yield data to be used in correlating placer deposits to specific bedrock types.

### C-Geology

The lithologies traverses in the Livengood area generally correspond to those mapped by Foster (1968) as well as to those mapped by Chapman, Weber, and Taber (1971). These rock units are to be described as they vary from one location to another differing in degree of metamorphism and alteration. A summary of these rock types as examined in the field follows.

#### Metasediments

Siliceous dolomite; light colored (white to tan), highly fractured and interbedded with chert.

Chert and siliceous mudstone; grey to black and brown with lighter bands in places. Typically fractured to a great extent with secondary fillings of silica and occasionally calcite.

Metagraywacke and conglomerate; grey to brown with sugary texture, medium to coarse grained. Recrystallization has occurred, obscuring sedimentary grain boundaries. Siliceous and argillite clasts range up to 1.5 cm - in size giving the rock a conglomeratic texture in some cases.

Slaty argillite to phyllite; grey to black, slaty and phyllitic meta-sediments of pelitic to psammitic composition and texture. Remnant laminations and other sedimentary structures such as fossils are partially preserved but have in most cases been obscured by low grade metamorphism. These rocks have been hornfelsed and metasomatized where in contact with younger, discordant intrusions and veins resulting in an extremely friable texture.

#### Igneous and meta-igneous rocks

Felsic dikes of monzonitic to granitic composition and associated quartz veins; these rocks are frequently sheared or bounded by shear zones, resulting in a cataclastic texture of breccia, microbreccia and gouge material. The gouge material is commonly grey to black and contains a clay-like material implying argillic alteration. Arsenopyrite is a common constituent in zones of this type, as seen on Lillian and Ruth Creeks. Felsic dike are variable in appearance due to differences in composition and varied alteration, sericitization, chloritization and silica enrichment.

Metabasalts and meta-andesites; dark green and black, fine grained and partially chloritized. Pyrite is common in both, occurring as fine disseminated cubes and blebs.

Serpentinites; light to dark green with some samples showing a black sheen on cleaved surfaces. Relict igneous textures are rare with a cataclastic texture predominating. Some inclusions of metabasalt or talc bearing material are present.

Metadiorite; green, fine to medium grained with a relict holocrystalline texture. Mafic minerals have been chloritized and are usually green. Minor pyrite or pyrrhotite are present.

#### D-Results and Preliminary Conclusions

Epithermal and probably mesothermal vein mineralization has occurred throughout the Money Knob, Amy Dome area in the Livengood district. Rocks of both sedimentary and igneous origin have been fractured, intruded by quartz and quartz sulfide veins, and extensive alteration has affected both parent rocks. These features show up in trenches, road cuts and placer operations where bedrock is exposed. It is likely that additional zones of mineralization exist although most seen so far are either of low grade or they are of small size.

### III-THE POTENTIAL FOR DIORITE TYPE ~~PORPHYRY~~ COPPER DEPOSITS, RAMPART GROUP

#### A-Introduction

In the 1976-78 field seasons the Mineral Industry Research Laboratory (MIRL) conducted the initial work on a pipeline corridor mineral evaluation study. Among their findings they reported a mineralized hornblende diorite sill-like body, containing as much as 10 percent sulfides, located just south of Hess Creek in the Livengood Quadrangle. One sample of diorite from this body contained 0.28 percent copper. MIRL concluded that "the occurrence of porphyry-type mineralization in rocks of the Rampart Group indicates that the terrane may have good mineral potential and may contain porphyry type deposits" (Robinson and Metz, 1979).

It was decided that, as part of the Bureau of Mines Pipeline Project for 1979, this area would be investigated further to determine its potential for containing porphyry copper type deposits.

In fulfilling this objective, the Hess Creek prospect was studied with a combination of geological, geochemical and geophysical methods to determine its major characteristics. These data were then a) compared to known characteristics of porphyry copper deposits in diorites, and b) used as a guide to locating other possible copper bearing diorite intrusives within the Rampart Terrane.

During the period of June 6 to 19, approximately 22 man days were spent on field work related to the diorite intrusives in the Rampart Group with three days of helicopter support.

#### B-Geochemistry

Approximately 85 rock and 70 soil samples were collected in the diorite intrusive bodies within the Rampart Terrane. The location of rock samples are scattered widely throughout the Livengood C-4 to C-6 and D-4 to D-6 Quadrangles. The soil samples, however, were all taken in the vicinity of the reported copper bearing diorite near Hess Creek.

Rock samples were generally representative samples of diorite bodies where they were found exposed in outcrop. Soil samples were collected by means of a gasoline engine powered auger to penetrate the permafrost layer near the surface.

#### C-Geology

The Rampart Group is mapped by Chapman, Weber, and Taber (1971) as Triassic and Permian extrusive and intrusive mafic rocks with some undifferentiated sedimentary rocks. Intrusive rocks include diorite, diabase, and gabbro.

MIRL noted a difference between the sill-like structure of diorite south of Hess Creek and the "clearly intrusive forms" north of Hess Creek. Our findings agree with those of MIRL: south of Hess Creek the diorite intrusives form fine to medium grained sills or dikes measuring a few feet in width while

north of Hess Creek the dominant form of the diorite is large (thousands of feet), irregularly shaped intrusive bodies.

Contact relations of the larger diorite intrusives is obscure: the contacts were usually marked by a zone of extensive shearing and alteration. This suggests that faulting was a dominant mechanism in their emplacement into their present positions. One exception to this is a diorite exposed along the north side of Hess Creek (Livengood C-4, T. 10 N., R. 5 W., Sec. 2). Here the diorite is in contact with fractured, bedded chert in what appears to be an intrusive relationship. The texture of the diorite becomes progressively finer grained within 50 to 100 feet of the chert, suggesting a chilled border zone. In addition, finer grained dikes (a few feet in width) of diorite composition intrude the chert and appear to be genetically related to the larger diorite body. This location is also significant in that it is one of the very few places that copper minerals were seen in hand specimen. A few blebs of chalcopyrite were noted in the diorite and malachite coated fractures in the chert over a small area near one of the diorite dikes. This occurrence is similar in general form to the Hess Creek occurrence where chalcopyrite is disseminated in a diorite dike and malachite coats fractures in both the diorite and chert country rock.

Exposure in the Livengood Quadrangle is poor - rarely were more than two outcrops exposed within the same diorite body.

#### D-Results and Preliminary Conclusions

No outcrops are visible in the vicinity of the Hess Creek occurrence; only float along the pipeline pad of diorite and chert with some chalcopyrite and malachite. Evidence elsewhere along the pipeline pad indicates that the rock forming the pad has been moved around extensively and in many cases has been trucked in from other locations. Thus geological evidence is almost non-existent and it was assumed that rock float along the pad might be unrelated to the bedrock. Due to the uncertainty an alternative method was sought for mapping diorite along the hillside. Because of the high magnetic contrast of magnetite rich diorite and the chert country rock, several magnetometer survey lines were run parallel to the pipeline. In general the magnetic character of the rocks in the area were very uniform, varying only 30 gammas over thousands of feet. This is the result expected from an area underlain almost entirely with chert. One dike was located striking nearly normal to the pipeline: detailed magnetometer lines mapped the dike's orientation and soil lines were run across the dike, transverse and running up and down the hillside. It is hoped that any copper associated with the dike will be present in the soil samples.

At the base of the hillside, just before the alluvial filled basin of Hess Creek, diorite and chert float containing copper minerals are very evident. Soil samples were also taken in this area, though no diorite bodies were detected by the magnetometer.

Limited geological evidence from both the Hess Creek pipeline occurrence and the occurrence in the Livengood C-4 mentioned previously suggest that concentrations of copper, where they occur, are limited to small diorite dikes or sills in the Rampart Group. No concentrations of copper were noted in hand specimen that would average more than a few tens of a percent copper. Thus, due to the low concentrations and low tonnages implied by a dike or sill-like

occurrence of disseminated copper in diorite, and the lack of significant copper mineralization or porphyry copper type alterations (such as potassic or propylitic), the Rampart area appears to have little potential for porphyry copper type deposits.



## A-Introduction

A linear belt of mafic-ultramafic rocks trends southwest-northeast for 70 miles in central Alaska forming the headwaters of the Kanuti and Melozitna Rivers. This belt intersects the Pipeline corridor just south of Old Man Camp, at Caribou Mountain. Patton and Miller (1970) reported that "although no significant mineral occurrences were found during the course of reconnaissance mapping, further investigation of these (ultramafic) bodies is believed to be warranted particularly for such related commodities as asbestos, platinum, chromium, and nickel." During the 1978 field season Karen Clautice (Alaska Field Operations Center, Fairbanks, Alaska) located and sampled several occurrences of chromite in the Caribou Mountain area. Beneficiation of the chromite samples indicated that the chromite is of metallurgical grade and also suitable for refractory use.

The northeast portion of this belt of ultramafic rocks was chosen for study during the 1979 field season of the pipeline project. Four separate ultramafic bodies were mapped and sampled in the area from Sithylemenkat Lake to Caribou Mountain. The emphasis during the course of field work was on chromite, but sample analysis will be given careful consideration for nickel, cobalt, and platinum.

Approximately 25 man days were devoted to work in the ultramafic belt including 7 days of helicopter support, during the time period July 9 to August 26.

## B-Geochemistry

Of the 200 geochemical samples collected within the ultramafic bodies, 75 percent were rocks, with the remainder split between soil, stream sediment and pans. Three large 75 pound rock samples of high grade chromite were taken in three different localities for beneficiation analysis.

A large percentage of the rock samples were taken during geologic traverses in a widely distributed pattern throughout the ultramafic bodies to establish background values for the various metals under consideration. Where chromite layers or bodies were encountered, rock channel samples were taken across the occurrences to obtain reliable estimates of their grade.

## C-Geology

The ultramafic rocks have been assigned a tentative Jurassic to Permian age by Patton and Miller (1973). They outcrop as individual, small (< 1 to 22 square miles) layered masses of chiefly serpentized dunite and serpentized peridotite. Layering is evident on a gross scale between individual units of dunite and peridotite, as well as on a smaller scale as parallel layers of chromite within the dunite. The layers generally dip northwestward 10° to 60°.

The southern side of all the bodies is abruptly terminated, suggesting a fault contact. The northern contacts appears to be gradational into mafic volcanic and intrusive rocks.

The rocks are characteristically red-brown on weathered surfaces and devoid of vegetation. The peridotites are typified by a "hobnail" surface due to the relative resistance to weathering of the pyroxene pseudomorphs. In contrast, the dunites have smooth exposed surfaces, except for the common resistant chrome spinels.

Within any of the ultramafic bodies studied the interlayered peridotite and dunite appear to be broken into large (one mile) blocks by faulting, with each block being rotated slightly from its neighbor.

#### D-Results and Preliminary Conclusions

The lack of substantial vegetation on the ultramafic bodies and the fact that the black, resistant chrome spinels stand out starkly against the pale brown weathered surfaces of the dunite make location of chromite concentrations relatively easy. Despite only a modest effort (25 man days for approximately 23 square miles of outcrop) two important and several minor occurrences of chromite were discovered in the 1979 field season.

In the Caribou Mountain ultramafic body, chromite occurrences noted by K. Clautice in 1978 were mapped with geology at 1:15,800 scale (1"=1/4 mile). At least seven separate layers, or pods, of chromite were mapped on two parallel ridges at the northeast corner of the Caribou Mountain ultramafic. The occurrences of chromite range from small disseminated grains forming layers up to several inches thick, to large (up to 1 foot) knotty masses of nearly 100 percent chromite. No bedrock occurrences of chromite, only rubble crop, were noted in the Caribou Mountain area. Beneficiation of a large bulk sample of chromite taken in 1978 from the Caribou Mountain area yielded 47.9 percent  $\text{Cr}_2\text{O}_3$  and a Cr to Fe ratio of 2.43.

To the southwest of Caribou Mountain the largest of the ultramafic bodies studied (16 square miles) contains two important and several minor chromite occurrences (see attached map). At the northeast end of the body multiple chromite layers are visible in outcrop. Layers of 70-80 percent chromite are up to 6" thick and separated by dunite layers of 6-11" in width. A six foot section of outcrop containing several layers of chromite was estimated in the field to contain 10-12 percent chromite. Strike length is uncertain due to tundra cover, but it is estimated at 150 feet.

Further to the southeast (see map) an area of outcrop rubble 50 feet x 150 feet contains abundant large (up to 9") knots of massive chromite. The ratio of chromite rubble to dunite rubble in this area is approximately 1:3

No visible sulfides were noted within the mafic-ultramafic rocks and the potential for concentrations of nickel and cobalt sulfides appears to be low. Geochemical samples, particularly the stream sediments, will be studied for anomalous concentrations of these elements. Pan samples taken in streams draining the ultramafic bodies will be analysed for platinum.

Based on our current work, the ultramafic belt of rocks in southeastern Bettles Quadrangle appears to be relatively favorable for the occurrence of alpine peridotite-podiform chromite deposits.

## A-Introduction

A belt of Cretaceous quartz monzonite plutons parallels the ultramafic belt previously described to the north and intersects the pipeline corridor in the southern Bettles Quadrangle (see map). Six of these plutons adjacent to the corridor were chosen for study. They include the Sithylemenkat, Hot Springs, Kanuti, and three unnamed plutons, which are referred to in this report as the Hamlin Hills, Coal Creek, and Ray River plutons.

Previous works by the Bureau of Mines (Clautice, 1978 and unpublished data) and the U.S.G.S. (Patton and Miller, 1973A) report several geochemical samples, both stream sediment and pan concentrates, with anomalous amounts of tin from the Sithylemenkat pluton. The samples were all taken near the headwaters of Kilolitna Creek.

In 1978 the Bureau of Mines (Karen Clautice, unpublished data) discovered an occurrence of metazeunerite in a small area of altered (propylitic?) rhyolite porphyry in the northwestern Hot Springs pluton. One high graded sample contained 1,000 ppm uranium.

The granitic rocks in the southern Bettles were chosen for study to:

- 1) Attempt to locate and define the source for the anomalous tin concentrations in Kilolitna Creek.
- 2) Investigate the metazeunerite occurrence in the Hot Springs pluton and try and locate other areas with similar uranium enrichment.
- 3) Compare the petrology of the granites in the Bettles Quadrangle to known tin granites and determine what similarities, if any, exist.
- 4) Locate and describe any deposits of tin, tungsten, uranium and other associated metals in the course of field work.
- 5) Through whole rock and thin section analysis and mapping determine the genetic relationship of the six individual plutons.

Forty-five man days were devoted to the study of the tin granites, with seven days of helicopter support and one day of fixed wing support. Where possible the plutons were mapped at 1:63,360 scale and numerous thin sections were taken of various phases within the intrusives.

## B-Geochemistry

During this investigation, 190 rock samples were collected. Most of these are to be analyzed for tin, tungsten, and uranium as well as other elements which might serve as indicators of mineralization. Some duplicate samples were collected so that petrographic analysis could be done on the various rock types. In addition to these procedures, numerous bulk samples were obtained for major oxide (whole rock) analysis in an attempt to determine the genetic relationship of the various plutons and intrusive phases. One hundred eleven additional samples were collected. These include 90 stream sediment and soil samples, with the remainder consisting of pan and sluice box concentrates, plus a dredge sample and a water sample. Splits from most of these will be chemically analyzed and, where possible, mineral grains will be identified.

The Kokrines-Hodzana Highlands are underlain by crystalline bedrock which includes pelitic schists, quartzites and phyllites of probable Paleozoic age. These metasediments are intruded in many places by granite and monzonite bodies of Cretaceous age. The genetic relationship of these various intrusions is unclear, however their geographic and geologic distribution, their similar ages and the gross petrologic similarities implies a close tectonic relationship and possibly one of comagmatic origin.

Few of these intrusives have been previously studied in detail, however a report by Patton and Miller (1970) on the Kanuti River region offers a general description of these Cretaceous granites and more detailed work has been completed by Herreid (1969) on the rocks of the Sithylemenkat Pluton. In general, the dominant rock type is a light colored, porphyritic rock ranging in composition from biotite granite to quartz monzonite. Potassium feldspar is ubiquitous and commonly occurs as euhedral perthitic phenocrysts up to 5 cm (2 in.) long. The groundmass is variable in grain size and texture, ranging from medium grained subequigranular to coarse grained, non-equigranular. Tourmaline occurs locally as fine needles or coarse, radiating aggregates. Whereas these plutons appear to be characterized by fairly consistent composition and texture, microlitic as well as chlorite or biotite rich segregations do occur. Abundant hematite and magnetite are generally associated with the latter. Commonly dissecting the coarser grained, granitic rocks are abundant dikes or segregations of alaskite or mafic poor differentiates. These are generally fine to medium grained and tend to show an equigranular texture. Outcrops of these granitic rocks exhibit advanced exfoliation along abundant, close spaced joint sets, resulting in the development of tors along prominent ridges.

## D-Summary and Preliminary Conclusions

Cretaceous granitic plutons within the Bettles and Beaver 1:250,000 Quadrangles were investigated for their potential as hosts for tin and uranium mineralization. Geologic traverses and geochemical sampling of the streams draining these areas were the primary modes of investigation. Scintillation counters were used during traverses to monitor changes in radiometric background and possibly locate areas of enriched uranium content. In general, a reconnaissance scale approach was adopted with traverses mapped at a scale of 1:63,360 and stream and pan samples collected from major and secondary tributaries. Where following up previous work such as the metazeunerite occurrence in the Hot Springs pluton and the anomalous tin values of the Sithylemenkat pluton, a more detailed approach was adopted. In these cases, the frequency of stream sampling was increased, as was the amount of time spent in a given area during traverse. Consequently, more attention was offered to the slightest changes in textural and compositional features of the bedrock. Rock samples were collected for both geochemical analysis and for petrographic examination. Any conclusions arrived at regarding the potential of such a large area would be premature without thorough examination of geochemical and petrographic data. This data is presently unavailable.

In lieu of this, certain features observed in the field bear mentioning at this point. The metazeunerite occurrence located by Clautice (1978) is associated with a narrow zone of altered rhyolite porphyry. The alteration

minerals include tourmaline, epidote, and sericite as well as a pervasive enrichment of silica. The metazeunerite occurs as disseminated grains which are barely visible with the naked eye. Surprisingly, no unusual levels of radioactivity were associated with these rocks. The fresh, unaltered rhyolite porphyry is white to tan in color and has a fine grained groundmass in which are set smokey quartz phenocrysts with occasional kaolinitized K-spar phenocrysts. Although this same rock type was observed elsewhere along the margins of the Hot Springs pluton, the alteration described above is more local. For this reason, the uranium mineralization also appears to be very local in extent.

Anomalous tin values have been obtained from the headwaters of Kilotitna Creek by both U.S.G.S. personnel (Patton and Miller, 1973A) and by Bureau of Mines personnel (Clautice, 1978 and unpublished data). The bedrock source of these values has not been located but the detailed sampling undertaken this summer should provide evidence for a better definition of this anomaly. The location of samples containing anomalous tin might be correlated with certain petrologic features observed in the field. These include a magnetite and hematite bearing, chlorite rich rock, derived from a granitic parent. Another feature noted in the field is the occurrence of a myrmekitic texture, with which tourmaline and minor sericite are associated. All these features are indicative of either post-magmatic crystallization or hydrothermal alteration. These conditions are favorable for enrichment of the element tin.

A detailed investigation of tungsten deposits along the northern contact of the Kanuti pluton was completed this summer as a separate Master's thesis project done by a Bureau of Mines employee. Although no data is available at this time a full prospect report will be available and included in the final report for the pipeline project.

Alluvial formations peripheral to the granitic plutons of the Kanuti Uplands were investigated for their potential to host placer tin deposits.

The Sithylemenkat pluton has been previously reported (Patton and Miller, 1970A) to contain anomalous geochemical values of tin.

Little other information on the mineral resources of this area, and in particularly tin deposits, has been compiled. Work by the Bureau of Mines in the 1978 field season as a reconnaissance for mineral resource potential of the proposed Kanuti Wildlife Refuge indicated tin placer potential on the margins of this pluton and to some extent on the margins of the Hot Springs pluton to the east.

Like many regions of the interior of Alaska, this particular area has not been significantly glaciated. Consequently alluvial deposits of gravel and sand derived from these uplifted plutonic and metamorphic rocks have accumulated over long periods of time uninterrupted by glaciation. This physiographic feature should be considered favorable for the formation of placer deposits hosting valuable heavy resistate minerals.

The economic characteristic of potential placer deposits are enhanced by the open, well drained character of the land, the generally plentiful supply of water, and the proximity of overland transportation. However, the presence of continuous permafrost would be a definite negative factor. It was projected that subeconomic, or possibly even economic large deposits of placer minerals may exist in alluvial plains such as those along the Kanuti-Kilolitna River, the upper Ray River and possibly the alluvial basin surrounding Sithylemenkat and Tokusatatquaten Lakes.

One of the objectives with regard to the 1979 study of the haul road corridor was to determine the eastward extension, if any, of the tin bearing provinces. Work was done intermittently between May and September of 1979, and consisted of approximately 35 man days of effort. In addition, more comprehensive pan concentrate survey was conducted within the corridor and was considered an internal part of the tin placer evaluation. During the field work bulk gravel samples were concentrated for further analytical work. Samples were collected from three different sites on the Kanuti-Kilolitna River, from 12 sites on an eastward tributary to this river and from an additional site on the upper Ray River. Most of these bulk sample sites, although outside of the present pipeline corridor, were selected for sampling because of the indicated presence of cassiterite and other minerals as a result of the 1978 investigation. It was felt necessary as a first step to show whether any deposits in the region would approach economic value. The pan concentrate survey will compliment this and indicate the extension, if any, eastward toward the pipeline corridor. Additional results have shown that significant quantities of tin were found at some sites, as well as interesting amounts of niobium and tantalum. Radiometric tests on the concentrates recovered also showed the strong presence of radioactive minerals which were tentatively identified as monozite and alanite. Further evaluation will have to await laboratory results. Sample procedures included measuring the amount of creek run gravel that was sampled; the amount of screened

undersize that was concentrated; the amount of concentrate recovered; and the physiographic features of the alluvial deposits.

Sample stations were selected with the emphasis on potential deposits of large volume which would be amenable to dredging or other large-scale operations. The many smaller creeks and drainages in the region will have to await further studies of a more comprehensive nature than was possible on this program. Some of these smaller creeks may indeed contain higher grade material indicative of their closer proximity to the source and would if mineralized be suitable for sluice boxes and smaller washing plants.

In a related placer investigation the gravels of the upper Dall River were examined for their heavy mineral content. The locality lies approximately 10 miles east of the pipeline haul road at a location where the river emerges from the small canyon onto a broader floodplain. Sampling showed significant quantities of gold in some of the gravel stratas for approximately one mile along the river. Due to the deeper nature of the gravels in this areas, the evaluation would be most tenuous at this time. However, it was shown that gold is indeed present, as well as the physical mechanics for placer formation of a potentially sizable deposit. The source for the gold appears to be the local metavolcanic rocks which trend northeasterly through the area. There have been no previous reports of gold in this region.

Four bulk samples of gravel were measured and concentrated from the upper Dall River.

It should be emphasized that in regard to placer investigation, surface sampling such as done in this study is only an indication of possible mineralization. No definite conclusions can be formulated without subsurface data from drilling or trenching.

## VII-COAL AND URANIUM IN TERTIARY SEDIMENTS

During the course of field investigations of the pipeline corridor this summer, Bureau personnel examined the Tertiary sedimentary rocks on the margins of the Yukon Flats.

In regard to coal, we initially studied the coal occurrences on Coal Creek, a tributary to the Dall River, approximately 12 miles east of the pipeline. These were previously briefly examined by the Bureau during the Rampart Dam study. Coal beds are poorly exposed and an auger hole to 18' indicated a continuous strata of gently dipping coal. It was not possible to drill to a greater depth to determine the true thickness of the coal seams in this area. A second occurrence of boulders of coal in beach gravels of the Dall River valley was found approximately 5 miles downstream from the first locality. This coal occurrence was not previously recorded. Tertiary rock appear to underly 5-10 square miles of the upper Dall River.

Boulders of coal were also found on the Ray River immediately adjacent to the Trans-Alaska Pipeline. At this locality it appears that four or five square miles of Tertiary rocks are probably present and additional Tertiary rocks may be covered by younger basalt flows.

Coal was found at two localities on the Hodzana River and it probably exists at a third. The coal is a lignite where seen in place, however, the second locality river float appears to be a good grade subbituminous. There are reports by Natives at Fort Yukon that subbituminous coal occurs as float at yet another locality further downstream.

There is an old uncertain report of thick coal seams on Lost Creek approximately 20 miles east of the haul road on the south side of the Yukon Flats. Attempts to locate this coal were unsuccessful but it did appear that Tertiary bedrock was in the area as mudstone and sandstone fragments were seen in the creek gravels. Boulders of coal were found along four or five miles of the Tozitna River valley approximately 35 miles west of the pipeline. This occurrence is also apparently previously unreported. Tertiary bedrock underlies at least 20-30 square miles of the valley. Coal samples from these localities are being analyzed for BTU grade, ash, fixed carbon, moisture and trace elements.

In regard to possible sedimentary uranium, some interesting characteristics of this possibility were found in Tertiary rocks this summer including minor values of uranium in mudstone and water lain ash bedrock samples from the Coal Creek area of the Dall River. These rock units are interbedded with porous sandstone (frequently containing abundant plant trash and locally oxidized), conglomerate and coal.

Near the Dall River and also on the upper Ray River areas of Tertiary rocks were found to be overlain by Quaternary basalts. This geologic model appeared favorable for uranium deposits although very little bedrock exposure and thick muskeg generally limited evaluation.

Slightly radioactive felsic volcanic were found in Tertiary sediments of Hodzana River area. A north following paleo-channel was followed to caldera



source with calcedonic alteration, leaching evidence and volcanic glass. Nearby mudstones contain unidentified bright blue phosphate nodules.

Extensive areas of soda-ash evaporites (trona, thermonatrite and feldspar) were located in a broad area southwest of Fort Yukon. These deposits may correlate to Tertiary sedimentation and appear to indicate degassing and ground water escapement of bedrock structures.

Further evaluations of potential sources of coal and uranium near and within the Yukon Flats should be made. Most of the localities mentioned are reasonably close to the pipeline haul road and a proposed future rail route. The coal could provide an energy source for any industrial development in the northern interior, as well as an alternate source for Fairbanks.

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